



DYNAMO: Budget and TRMM Product Intercomparisons

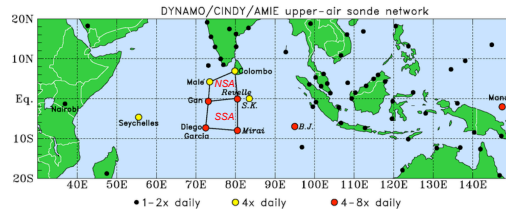
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Introduction

The Dynamics of the MJO (DYNAMO) field campaign, along with companion projects AMIE and CINDY, was carried out in the Indian Ocean to study atmosphere and ocean processes associated with the initiation of the Madden-Julian Oscillation (MJO). Here we report *rainfall rate* and *Q_1/Q_2 profile* estimates from heat and moisture budgets and comparison with various TRMM products.



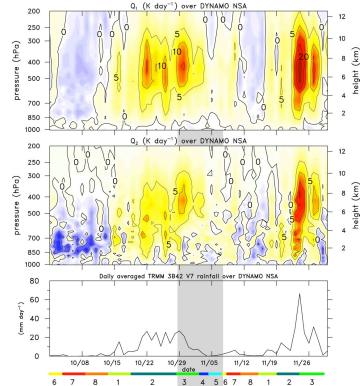
Rainfall rates (P_0) for the October-November 2011 Special Observing Period (SOP) are computed for the northern and southern sounding arrays (NSA and SSA, respectively, depicted above) as a residual from

$$P_0 = < Q_2 > / L + E_0,$$

where E_0 is the surface latent heat flux from TropFlux, angle brackets indicate integrals through the depth of the troposphere, and hydrometeor storage is neglected.

Time series of Q_1 and Q_2 for NSA

Q_1 , Q_2 , and rainfall over Northern Sounding Array (NSA)

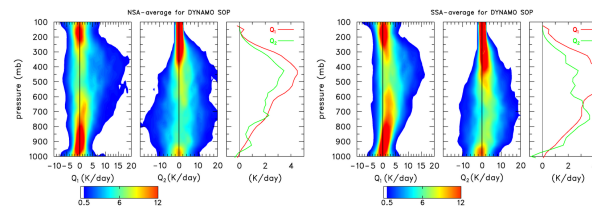


Time series of Q_1 and Q_2 for NSA, TRMM 3B42 rainfall, and Wheeler-Hendon MJO Index (bottom color bar). Shading denotes time when R/V Reville was off station (from Johnson et al. 2015, JAS).

- Northern array sounding network captures prominent signals of heating/drying associated with active phases of each MJO
- Similar inferred evolution of dominant convective modes for both MJOs: shallow, non-precipitating clouds to congestus to deep convection to stratiform precipitation
- Shorter duration of each convective mode for November MJO than October MJO

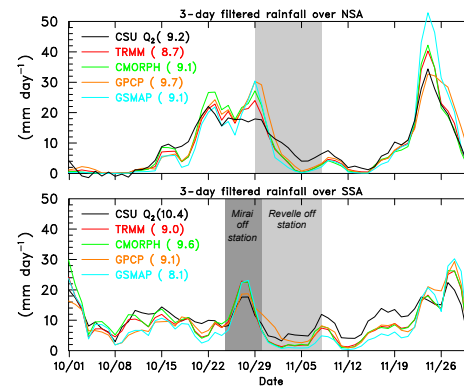
Q_1/Q_2 profiles for Northern and Southern Arrays

SOP-mean Q_1 and Q_2 CFADS and profiles for NSA and SSA



- Implications of Q_1/Q_2 profiles: NSA has greater stratiform rain fraction (SF) than SSA – supported by TRMM 2A25 data (SF = 55% for NSA, 50% for SSA)
- Results consistent with findings by Lin et al. (2004) that MJO (which is more dominant over the NSA) has greater stratiform rain fraction than tropical mean

Comparison of rainfall rates: budgets and satellites



Time series of rainfall rate estimates from budgets and satellites (TRMM 3B42, CMORPH, GPCP, and GSMap); SOP-mean values in parentheses.

- Temporal variability and mean values in generally good agreement; correlations of daily-averaged budget and TRMM values near 0.90
- Satellites underestimate (overestimate) rainfall in dry (wet) periods
- Evidence of hydrometeor storage over NSA during October MJO: budget rainfall exceeds satellite estimates during build-up phase in mid-October, opposite occurs at the end of October

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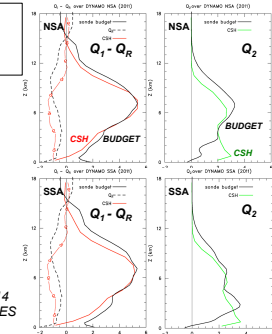
Comparison of budgets with CSH/SLH LH products

NSA/SSA Q_1 - Q_R , Q_2 profiles: budgets vs. CSH

CSH (3H25): Tao et al. (1993, 2000, 2001, 2006, 2010)
SLH (3H31): Shige et al. (2004, 2007, 2008, 2009)

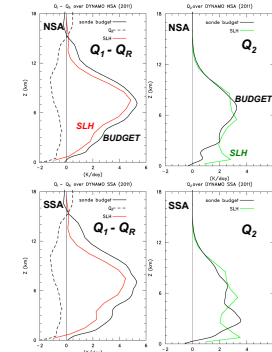
- Q_1 profiles similar for NSA and SSA; good agreement with CSH
- Budget Q_2 profiles differ between N and S arrays; Q_1/Q_2 structures suggest greater stratiform rain fraction over NSA than SSA
- CSH has same Q_2 profile for both arrays

(Q_R from Feng et al. 2014 based on Gan and CERES observations)



NSA/SSA Q_1 - Q_R , Q_2 profiles: budgets vs. SLH

- Q_1 - Q_R profiles similar for NSA and SSA; SLH amplitude slightly less
- SLH (as for CSH) has nearly same Q_2 profile for both arrays; implies similar cloud populations whereas budgets do not
- Sensitivity of TRMM instruments prevents detection of shallow, non-precipitating convection with attendant low-level moistening, which likely explains the excessive low-level drying in their Q_2 estimates.



Conclusions

- Evolution of Q_1 and Q_2 during DYNAMO: consistent with shallow cumulus-congestus-deep convection-stratiform cloud population evolution; duration of convective modes shorter for November MJO
- Good agreement between P_0 from budgets and TRMM 3B42 data; satellites under- (over-) estimate rainfall rates during dry (wet) periods; some evidence of cloud storage effects in build-up and decay phases for October MJO
- Latent heating profiles from CSH and SLH LH algorithms in reasonable agreement with budget results: Q_2 profiles from CSH/SLH exhibit larger differences from budgets